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Liu

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(54) **DISPLAY CONTROL METHOD USED IN DISPLAY APPARATUS WITH MULTIPLE COLOR LIGHT SOURCES**

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G09G 3/34 (2006.01)

(52) **U.S. Cl.**
CPC ***G09G 3/3413*** (2013.01); *G09G 2310/0235* (2013.01); *G09G 2320/0242* (2013.01); *G09G 2360/16* (2013.01)

(58) **Field of Classification Search**
CPC G09G 3/34; G09G 3/36; G09G 5/02; G09G 5/10
USPC 345/84, 87, 88, 102, 589–605, 690
See application file for complete search history.

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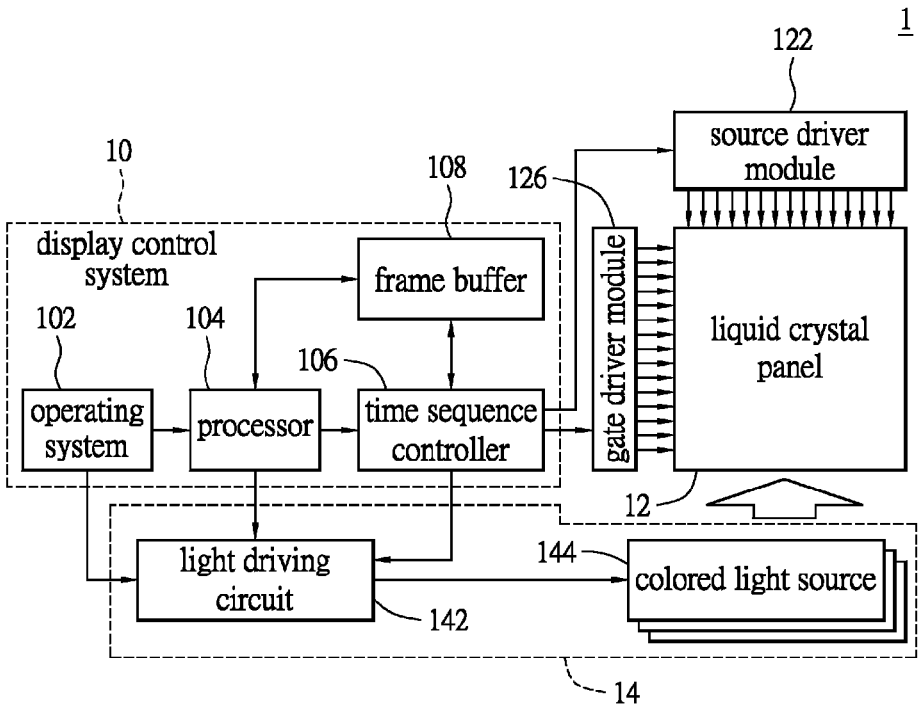
(57) **ABSTRACT**

A display control method used in a display apparatus with multiple colored light sources, wherein the colored light sources emit different color lights, the color cast sub frame in the frame of the display apparatus tends to a specific color, and the display control method comprises for the frame, increasing the specific color light source of the frame and decreasing the other color light source of the frame. For the white-tending sub frame of the frame, sub-pixel values of the specific color are decreased according to the increasing level of the specific color light source to generate modified sub-pixel values. For the white-tending frame, the modified sub-pixel values and the sub-pixel values of the other colors are increased according to the decreasing level of the other colored light sources.

20 Claims, 8 Drawing Sheets



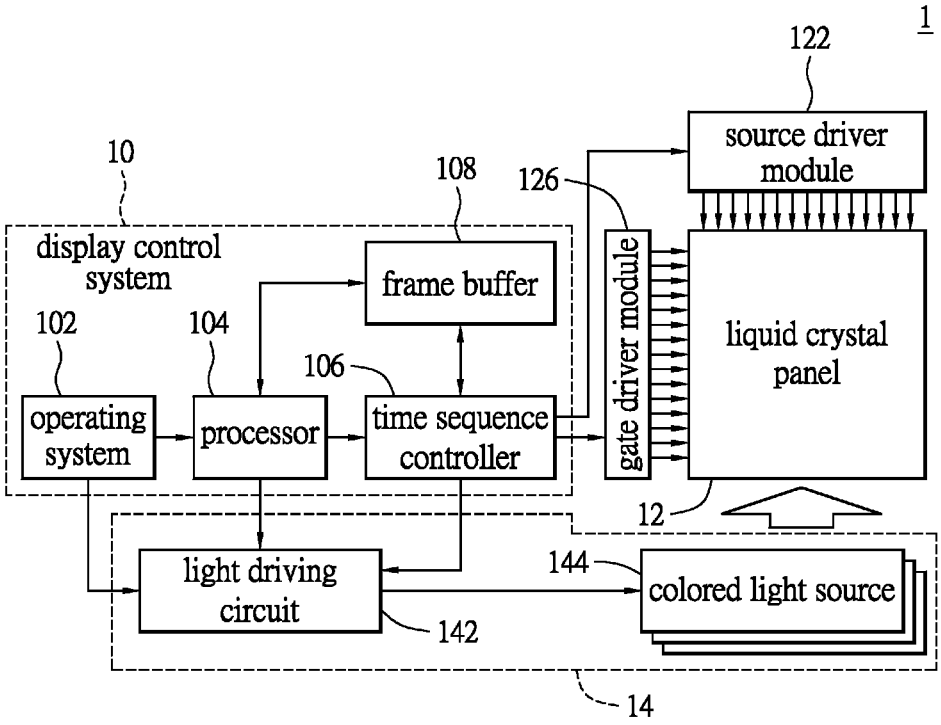

1
122
source driver module
10
108
126
display control system
frame buffer
gate driver module
liquid crystal panel
102
104
106
operating system
processor
time sequence controller
12
light driving circuit
144
colored light source
142
14

FIG.1A

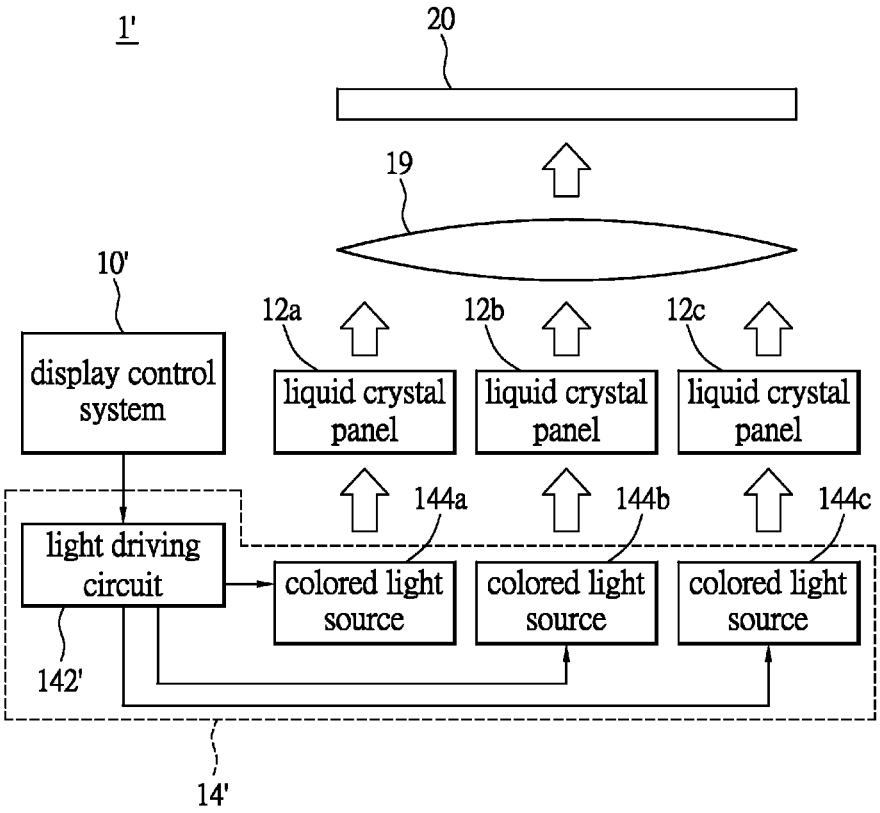

1'
20
19
10'
12a
12b
12c
display control system
liquid crystal panel
liquid crystal panel
liquid crystal panel
144a
144b
144c
light driving circuit
colored light source
colored light source
colored light source
142'
14'

FIG.1B

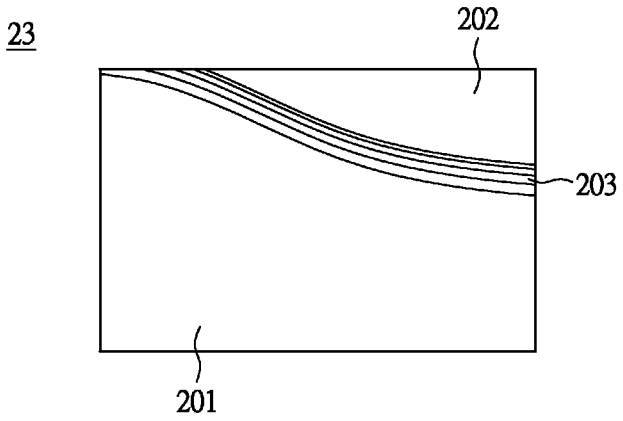


FIG.2A

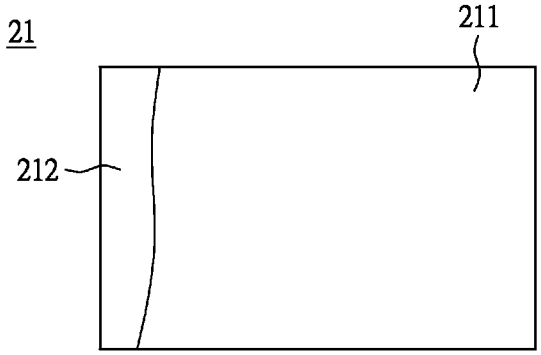


FIG.2B

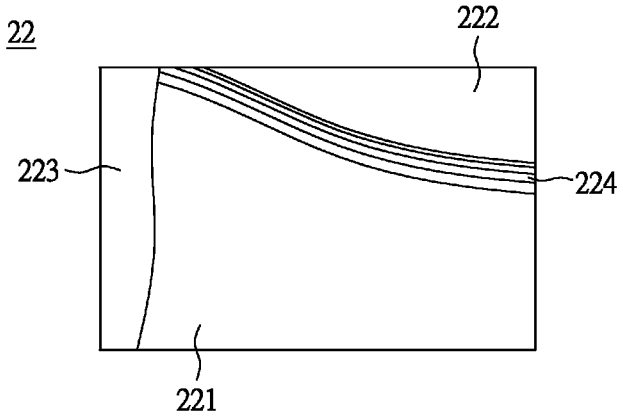


FIG.2C

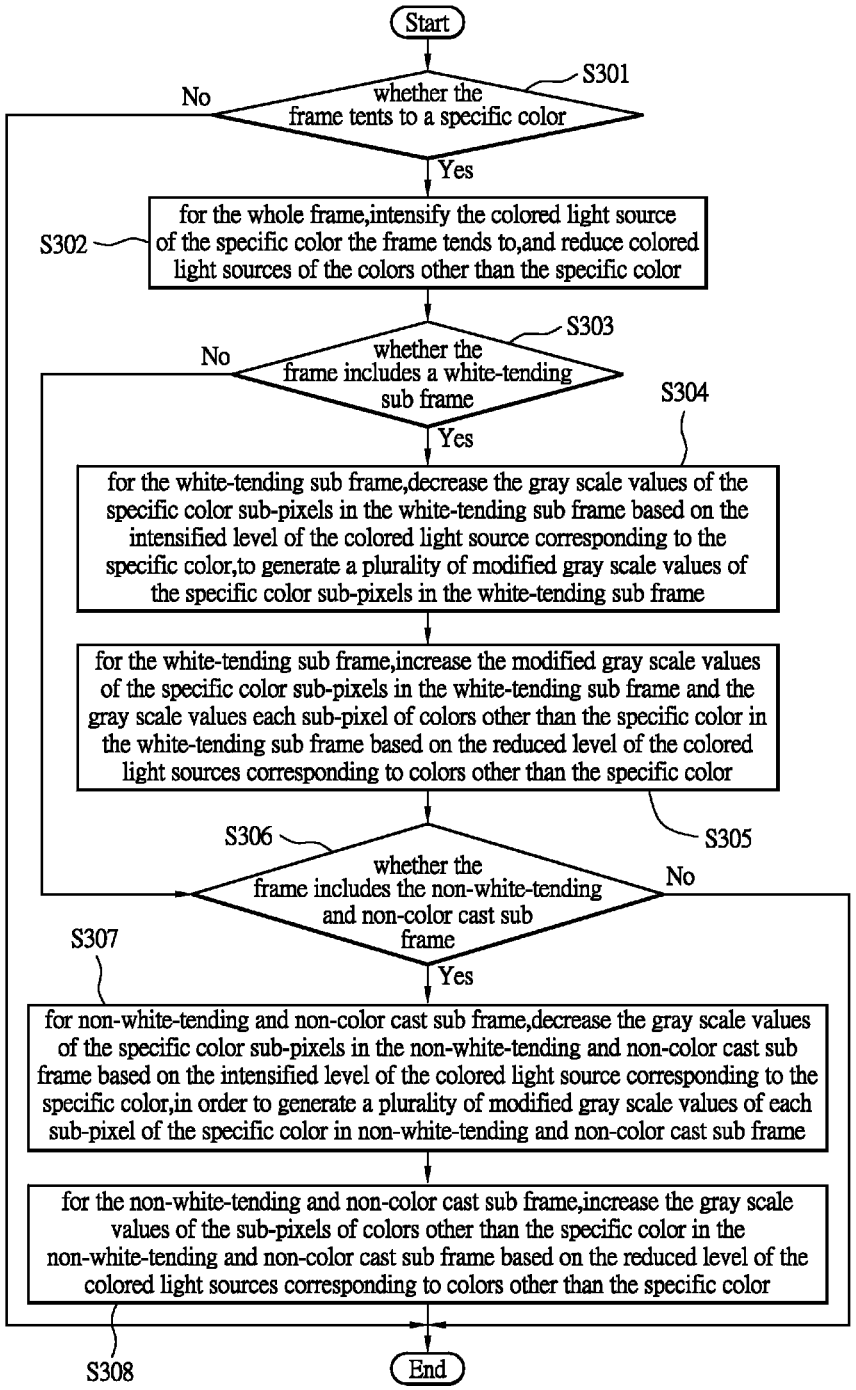

Start
S301
whether the frame tents to a specific color
No
Yes
S302
for the whole frame,intensify the colored light source of the specific color the frame tends to,and reduce colored light sources of the colors other than the specific color
S303
whether the frame includes a white-tending sub frame
No
Yes
S304
for the white-tending sub frame,decrease the gray scale values of the specific color sub-pixels in the white-tending sub frame based on the intensified level of the colored light source corresponding to the specific color,to generate a plurality of modified gray scale values of the specific color sub-pixels in the white-tending sub frame
for the white-tending sub frame,increase the modified gray scale values of the specific color sub-pixels in the white-tending sub frame and the gray scale values each sub-pixel of colors other than the specific color in the white-tending sub frame based on the reduced level of the colored light sources corresponding to colors other than the specific color
S305
S306
whether the frame includes the non-white-tending and non-color cast sub frame
No
Yes
S307
for non-white-tending and non-color cast sub frame,decrease the gray scale values of the specific color sub-pixels in the non-white-tending and non-color cast sub frame based on the intensified level of the colored light source corresponding to the specific color,in order to generate a plurality of modified gray scale values of each sub-pixel of the specific color in non-white-tending and non-color cast sub frame
for the non-white-tending and non-color cast sub frame,increase the gray scale values of the sub-pixels of colors other than the specific color in the non-white-tending and non-color cast sub frame based on the reduced level of the colored light sources corresponding to colors other than the specific color
S308
End

FIG.3

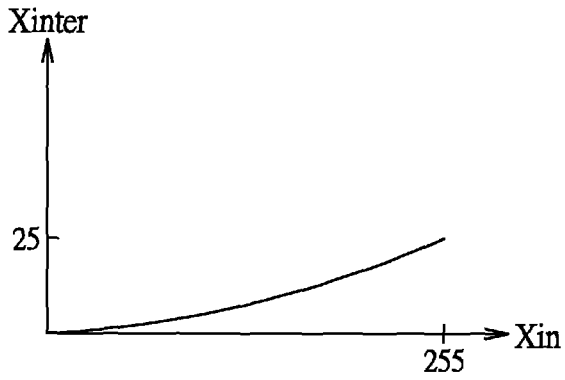


FIG.4A

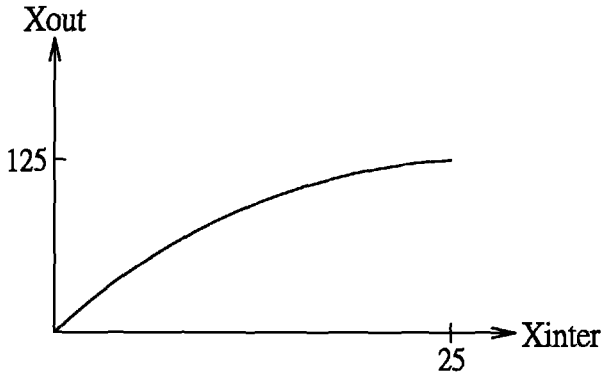


FIG.4B

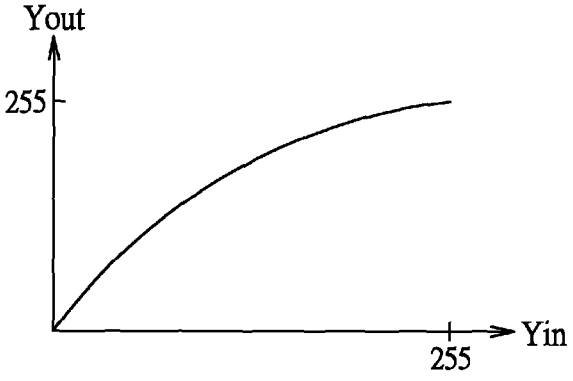


FIG.4C

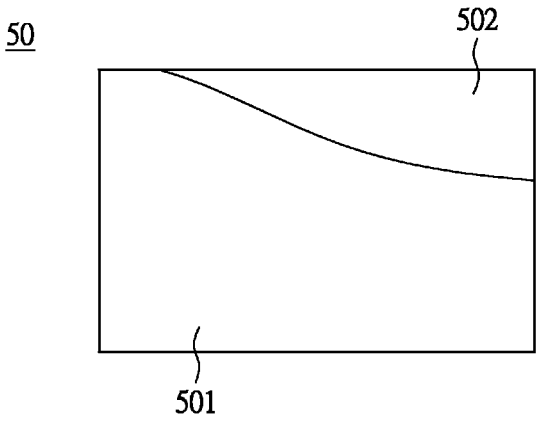


FIG.5A

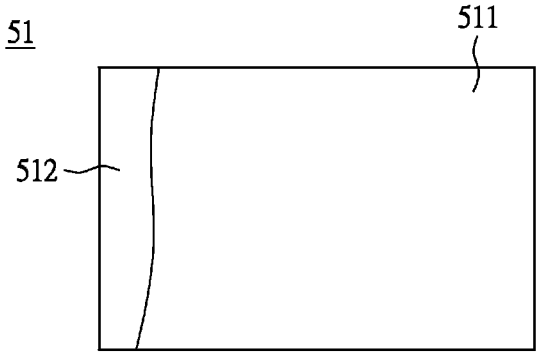


FIG.5B

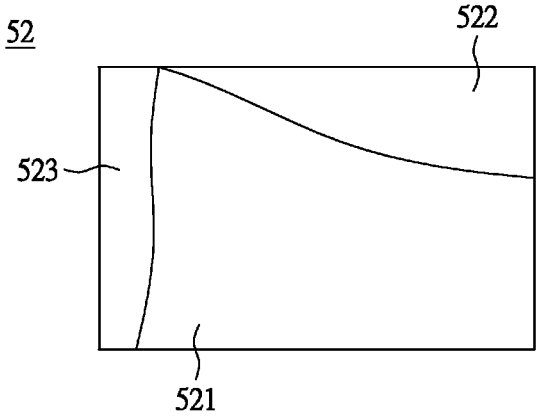


FIG.5C

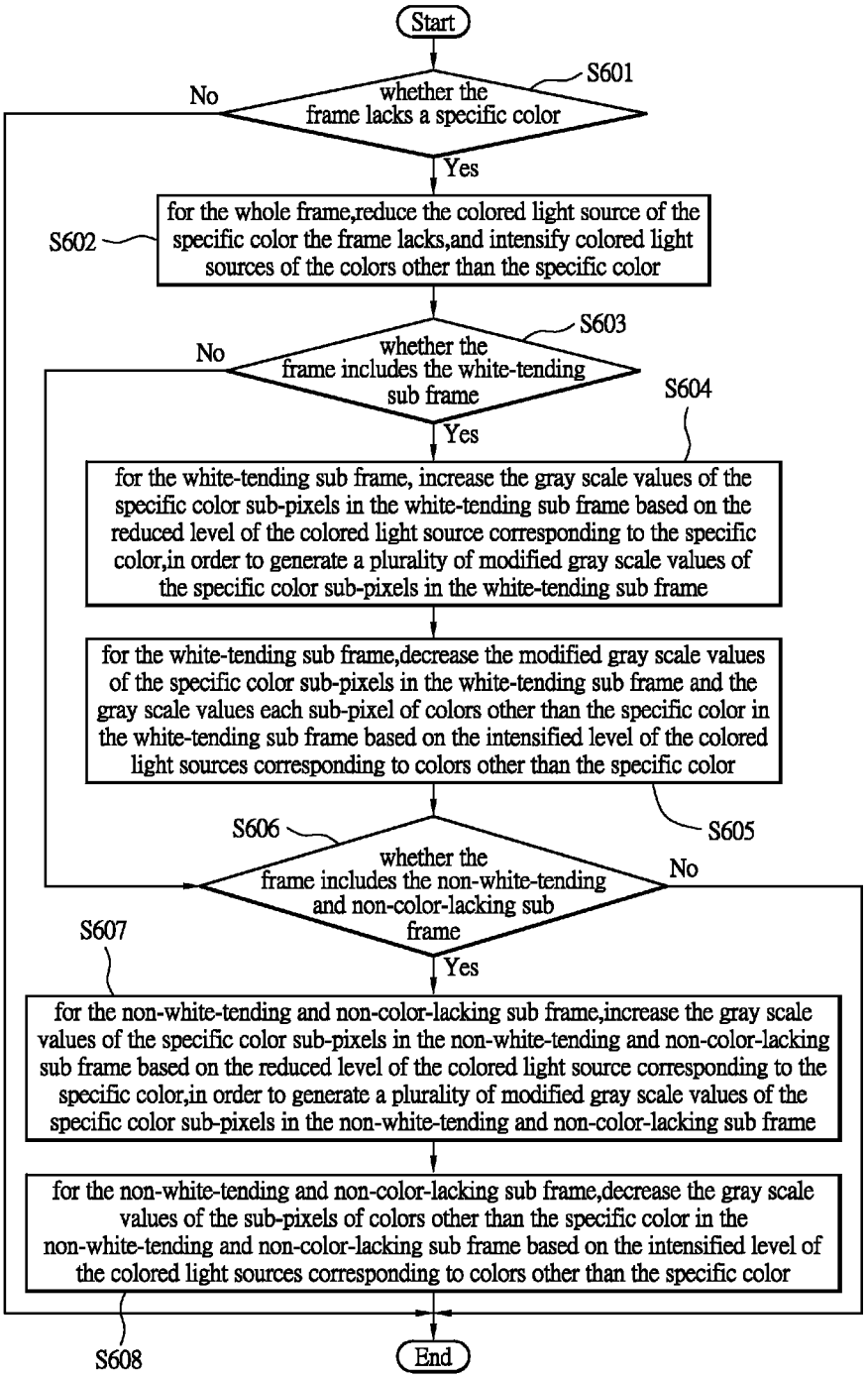

Start
S601
whether the frame lacks a specific color
No
Yes
S602
for the whole frame,reduce the colored light source of the specific color the frame lacks,and intensify colored light sources of the colors other than the specific color
S603
whether the frame includes the white-tending sub frame
No
Yes
S604
for the white-tending sub frame, increase the gray scale values of the specific color sub-pixels in the white-tending sub frame based on the reduced level of the colored light source corresponding to the specific color,in order to generate a plurality of modified gray scale values of the specific color sub-pixels in the white-tending sub frame
for the white-tending sub frame,decrease the modified gray scale values of the specific color sub-pixels in the white-tending sub frame and the gray scale values each sub-pixel of colors other than the specific color in the white-tending sub frame based on the intensified level of the colored light sources corresponding to colors other than the specific color
S605
S606
whether the frame includes the non-white-tending and non-color-lacking sub frame
No
S607
Yes
for the non-white-tending and non-color-lacking sub frame,increase the gray scale values of the specific color sub-pixels in the non-white-tending and non-color-lacking sub frame based on the reduced level of the colored light source corresponding to the specific color,in order to generate a plurality of modified gray scale values of the specific color sub-pixels in the non-white-tending and non-color-lacking sub frame
for the non-white-tending and non-color-lacking sub frame,decrease the gray scale values of the sub-pixels of colors other than the specific color in the non-white-tending and non-color-lacking sub frame based on the intensified level of the colored light sources corresponding to colors other than the specific color
S608
End

FIG.6

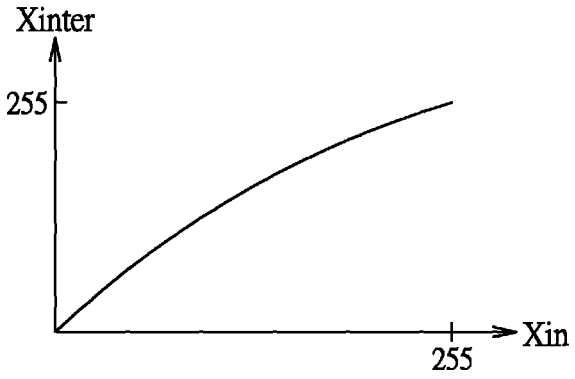


FIG.7A

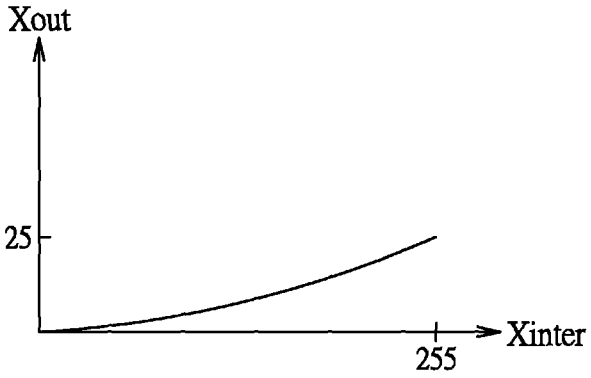


FIG.7B

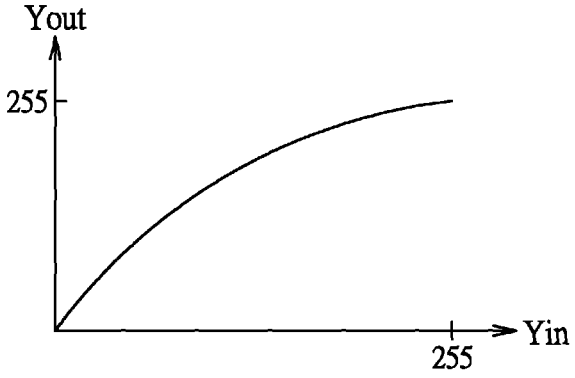


FIG.7C

DISPLAY CONTROL METHOD USED IN DISPLAY APPARATUS WITH MULTIPLE COLOR LIGHT SOURCES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present disclosure relates to a display apparatus; in particular, to a display control method used in a display apparatus having multiple colored light sources.

2. Description of Related Art

Nowadays the development of display technology grows fast, wherein liquid crystal displays (LCD) are wildly used to be video output apparatus of various kinds of electronic devices. In the markets, some of the LCDs have multiple colored light sources, such as a color sequential display having red, green, and blue colored light sources.

In the display apparatus having multiple colored light sources, a frame cycle could be divided into three sub cycles from a first sub-frame cycle to a third sub-frame cycle, and red, green, and blue colored lights would respectively be opened in the first, the second, and the third sub-frame cycle. Therefore, the display apparatus having multiple colored light sources may smoothly display colors of each pixel designated by the video data. Briefly speaking, the color and brightness of each pixel of the display apparatus having multiple colored light sources is composed by the value of red light, green light, and blue light that passes the liquid crystal at different time.

Besides, it is worth to mention that the most energy consuming part of a display apparatus is the colored light sources. Hence, it is necessary to properly adjust the brightness and intensity of the colored light sources to make the display apparatus more energy-saving and economical.

SUMMARY OF THE INVENTION

The present disclosure provides a display control method, adopted to a display apparatus having multiple colored light sources used to emit multiple color light of different colors, in which a frame of the display apparatus includes at least a color cast sub frame and at least a white-tending sub frame, wherein the color cast sub frame tends to at least a specific color that is able to be divided into at least one of the colored light of the one or more different colors. The method comprises steps of: for the frame, intensifying the colored light source of the specific color and reducing the colored light sources of colors other than the specific color; for the white-tending sub frame, decreasing a plurality of gray scale values corresponding to the specific color in the white-tending sub frame based on a level that the colored light source of the specific color is intensified, to generate a plurality of modified gray scale values; and for the white-tending sub frame, increasing the plurality of modified gray scale values and a plurality of gray scale values corresponding to the colors other than the specific color based on a level that the colored light sources of the colors other than the specific color are reduced.

In one embodiment of the present disclosure, the above-mentioned frame further includes at least a non-white-tending and non-color cast sub frame. The above-mentioned display control method further comprises steps of: for the non-white-tending and non-color cast sub frame, decreasing a plurality of gray scale values corresponding to the specific color in the non-white-tending and non-color cast sub frame based on a level that the colored light source of the specific color is intensified, to generate a plurality of modified gray scale values; and for the non-white-tending and non-color cast sub frame, increasing a plurality of gray scale values corresponding to the colors other than the specific color based on a level that the colored light sources of the colors other than the specific color are reduced.

Additionally, the present disclosure provides another display control method, adopted to a display apparatus having multiple colored light sources used to emit multiple color light of different colors, in which a frame of the display apparatus includes at least a color-lacking sub frame and at least a white-tending sub frame, wherein the color-lacking sub frame lacks for at least a specific color that is able to be divided into at least one of the colored light of the one or more different colors. The display control method comprises steps of: for the frame, reducing the colored light source of the specific color and intensifying the colored light sources of colors other than the specific color; for the white-tending sub frame, increasing a plurality of gray scale values corresponding to the specific color in the white-tending sub frame based on a level that the colored light source of the specific color is reduced, to generate a plurality of modified gray scale values; and for the white-tending sub frame, decreasing the plurality of modified gray scale values and a plurality of gray scale values corresponding to the colors other than the specific color based on a level that the colored light sources of the colors other than the specific color are intensified.

In one embodiment of the present disclosure, the above-mentioned frame further includes at least a non-white-tending and non-color-lacking sub frame. The above-mentioned display control method further comprises steps of: for the non-white-tending and non-color-lacking sub frame, increasing a plurality of gray scale values corresponding to the specific color in the non-white-tending and non-color-lacking sub frame based on a level that the colored light source of the specific color is reduced, to generate a plurality of modified gray scale values; and for the non-white-tending and non-color-lacking sub frame, decreasing a plurality of gray scale values corresponding to the colors other than the specific color in the non-white-tending and non-color-lacking sub frame based on a level that the colored light sources of the colors other than the specific color are intensified.

In summary, the present disclosure provides the display apparatus and the display control method. The display control method could reduce power consumption of the multiple colored light sources of the display apparatus. Furthermore, it does not require greater complexity to implement the display apparatus and the display control method, and thus the device and the method are suitable for mass producing related products and are highly practical.

For further understanding of the present disclosure, reference is made to the following detailed description illustrating the embodiments and examples of the present disclosure. The description is only for illustrating the present disclosure, not for limiting the scope of the claim.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**A shows a block diagram of a display apparatus according to one embodiment of the present disclosure;

FIG. **1**B shows a block diagram of a display apparatus according to another embodiment of the present disclosure;

FIG. **2**A shows an illustrative diagram of a frame having a white-tending sub frame and a color cast sub frame according to an embodiment of the present disclosure;

FIG. **2**B shows an illustrative diagram of a frame having a white-tending sub frame, a non-white-tending and non-color

cast sub frame, and a color cast sub frame according to an embodiment of the present disclosure;

FIG. **2**C shows an illustrative diagram of a frame having a non-white-tending and non-color cast sub frame and a color cast sub frame according to an embodiment of the present disclosure;

FIG. **3** shows a flow chart of a display control method according to one embodiment of instant disclosure;

FIG. **4**A shows a curve graph of gray scale values of sub-pixel of a specific color versus modified gray scale values of sub-pixels modified based on the intensified level of the colored light source of the specific color according to one embodiment of the present disclosure;

FIG. **4**B shows a curve graph of modified gray scale values of sub-pixel of a specific color versus modified gray scale values of sub-pixels increased based on the reduced level of the colored light sources of the colors other than the specific color according to one embodiment of the present disclosure;

FIG. **4**C shows a curve graph of gray scale values of sub-pixel of the colors other than the specific color versus modified gray scale values of sub-pixels increased based on the reduced level of the colored light source of the colors other than the specific color according to one embodiment of the present disclosure;

FIG. **5**A shows an illustrative diagram of a frame having a white-tending sub frame and a color-lacking sub frame according to an embodiment of the present disclosure;

FIG. **5**B shows an illustrative diagram of a frame having a white-tending sub frame, a non-white-tending and non-color-lacking sub frame, and a color-lacking sub frame according to an embodiment of the present disclosure;

FIG. **5**C shows an illustrative diagram of a frame having a non-white-tending and non-color-lacking sub frame and a color-lacking sub frame according to an embodiment of the present disclosure;

FIG. **6** shows a flow chart of display control method according to another embodiment of instant disclosure;

FIG. **7**A shows a curve graph of gray scale values of sub-pixel of a specific color versus modified gray scale values of sub-pixels increased based on the reduced level of the colored light source of the specific color according to one embodiment of the present disclosure;

FIG. **7**B shows a curve graph of modified gray scale values of sub-pixel of the specific color versus modified gray scale values of sub-pixels decreased based on the intensified level of the colored light sources of the colors other than the specific color according to one embodiment of the present disclosure; and

FIG. **7**C shows a curve graph of gray scale values of sub-pixel of the colors other than the specific color versus modified gray scale values of sub-pixels decreased based on the intensified level of the colored light source of the colors other than the specific color according to one embodiment of the present disclosure.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The aforementioned illustrations and following detailed descriptions are exemplary for the purpose of further explaining the scope of the instant disclosure. Other objectives and advantages related to the instant disclosure will be illustrated in the subsequent descriptions and appended drawings.

[Display Apparatus Embodiment]

Referring to FIG. **1**A, it shows a block diagram of a display apparatus according to one embodiment of the present disclosure. The display apparatus **1** includes a display control system **10**, a liquid crystal panel **12**, a source driver module **122**, a gate driver module **126**, and a light source module **14**. The display control system **10** is electronically connected to the source driver module **122**, the gate driver module **126**, and the light source module **14**.

In the present embodiment, the display apparatus **1** has a plurality of light sources **144**. Furthermore, the light source module **14** may be a backlight source module and front light source module (having front light guide panel). The light source module **14** includes a light source driving circuit **142** and multiple colored light sources **144**. The multiple colored light sources **144** may be such as red, blue, green, white, cyan, purple, orange, and yellow. Majority of the multiple colored light sources **144** may include red, green, and blue light sources, or include red, green, blue, yellow, and white light sources. Meanwhile, the liquid crystal panel **12** may be selectively equipped with color filters.

The display control system **10** controls the light source driving circuit **142** to drive various colored light sources **144** and controls the gate driver module **126** and the source driver module **122**. The light source driving circuit **142** receives a control signal from the display control system **10** to generate a driving current in order to control the multiple colored light sources **144** of the light source module **14** to be switched on or off, and to adjust brightness and intensity of the colored light emitted from the multiple colored light sources **144** of the light source module **14**. In other words, the multiple colored lights emitted from the multiple colored light sources **144** include various light intensities (e.g. using 4 bits to create 16 kinds of light intensities), and the multiple colored lights emitted from the multiple colored light sources **144** have various light intensities to be adjusted. The light source module **14** may transmit the colored light generated by the colored light sources **144** to the liquid crystal panel **12**. Each of the multiple colored light sources **144** is switched on or off, or modifies the brightness or intensity of the corresponding colored light according to the intensity of the received driving current.

The multiple colored light sources **144** may correspondingly provide multiple colored lights to a whole frame of the display apparatus. However, the whole frame may be divided into several physical independent sub frames, to which the multiple colored light sources **144** may correspondingly provide multiple colored light.

In short, the multiple colored light sources **144** that provide colored light to the several physical independent sub frames could be controlled independently. Each of the multiple colored light sources **144** may provide the colored light to the whole frame, or provide the colored light to different physical independent sub frames in a time-sharing manner. Meanwhile, the liquid crystal of the sub-pixel corresponding to the multiple colored light sources **144** would be controlled by section or in a time-sharing manner. For example, the liquid crystal of the sub-pixel corresponding to the multiple colored light sources **144** would be controlled in the time-sharing manner during the several sub frame cycles of the frame cycle.

The gate driver module **126** is controlled by the display control system **10** to generate gate driving signal, in order to switch an array of transistors of a thin-film transistor matrix of the liquid crystal panel **12** on or off. The source driver module **122** is controlled by the display control system **10** to generate a plurality of driving voltages corresponding to the video data to the array of transistors which is switched on, in order to control the liquid crystal of the pixels of the array and further adjust transmittance of the pixels of the array or adjust the driving voltages of the liquid crystals.

The display control system **10** includes an operating system **102**, a processor **104**, a time sequence controller **106**, and a frame buffer **108**. The operating system **102** is electronically connected with the processor **104** which electronically connects to the time sequence controller **106** and the frame buffer **108**. The time sequence controller **106** is electronically connected with the frame buffer **108**, the light source driving circuit **14**, the source driver module **122**, and the gate driver module **126**. In other embodiments, the display control system **10** may further include external or built-in graphic card (not shown in FIG. **1**A).

The operating system **102** may be an embedded operating system, common software operating systems, or a graphic card control system. The operating system **102** may control the processor **104** to process video data of the frames, and perform a display control method. Therefore, the display control system **10** could control to switch the multiple colored light sources **144** of the light source module **14** on/off and the brightness of the multiple colored light sources **144**, as well as utilizing pulse width modulation (PWM) technique to change pulse frequency for adjusting the intensity and brightness of the colored light emitted from the multiple colored light source **144**, so as to reduce the power consumption of the display apparatus **1**.

Moreover, through the display control method, the display control system **10** may further adjust gray scale of each sub-pixel of the frame, in order to prevent white-tending sub frame and non-white-tending sub frame and non-color cast sub frame (or non-white-tending sub frame and non-color-lacking sub frame) from tending to (or lacking) at least one color due to adjustment of the intensity and brightness of the colored light emitted from the multiple colored light source **144**.

In addition, in the present embodiment, the video data of the frame may be jointly processed and computed by the operating system **102**, external or built-in graphic card, and the processor **104**, or, on the other hand, be processed and computed simply by the operating system **102** or the graphic card to implement the display control method.

The frame buffer **108** is configured to receive and catch the video data of the frame to be shown. The time sequence controller **106** receives the outcome obtained via performing the display control method to process the video data of the frame from the processor **104**, and controls the light source driving circuit **14**, source driver module **122**, and the gate drover module **126** based on the outcome, so that the switch-on/off of the multiple colored light of the light source module **16** may be controlled and the intensity and brightness of the colored light emitted from the multiple colored light source **144** may be controlled to save power. Furthermore, to prevent white-tending sub frame and non-white-tending sub frame and non-color cast sub frame (or non-white-tending sub frame and non-color-lacking sub frame) from tending to (or lacking) at least one color due to adjustment of the intensity and brightness of the colored light emitted from the multiple colored light source **144**, the time sequence controller **106** may even adjust the gray scale value of each sub-pixel.

It is worth mentioning, the type of display apparatus **1** shown in FIG. **1**A is not intended to limit the present invention. In the embodiments of the present invention, the display apparatus may be a TFT LCD device, a transmission or reflecting projecting display apparatus, a reflecting micro display apparatus, or display apparatus with multiple color light emitting diodes (LEDs), organic light emitting diodes (OLEDs), or electroluminescence (EL). Examples of transmission or reflecting projecting display apparatus may be high temperature poly-silicon (HTPS), low temperature poly-silicon (LTPS), or liquid crystal on silicon (LCOS) projecting display apparatus. The reflecting projecting display apparatus may further be digital light processing (DLP), LCOS, or MEMS mirror display apparatus. In addition, the colored light sources may be implemented via colored light laser sources, colored light LEDs, colored light EL, colored light OLEDs, cold cathode fluorescent lamp (CCFL), mercury lamp with color filters, helium lamp with color filters, or the mercury lamp or the helium lamp with color wheel.

[Another Display Apparatus Embodiment]

Please refer to FIG. **1**B which shows a block diagram of a display apparatus according to another embodiment of the present disclosure. The display apparatus **1'** shown in FIG. **1**B is a HTPS transmission projecting display apparatus. The display apparatus **1'** includes a display control system **10'**, a source driver module (not shown in FIG. **1**B), a gate driver module (not shown in FIG. **1**B), a light source module **14'**, liquid crystal panels **12***a*-**12***c*, and a converging lens **19**. The light source module **14'** includes a light source driving circuit **142'** and multiple colored light sources **144***a*-**144***c*. The display control system **10'** and the light source driving circuit **142'** are substantially the same as the display control system **10** and the light source driving circuit **142** shown in FIG. **1**A, and therefore details of which would be omitted in this embodiment. The source driver module and the gate driver module respectively includes multiple source driver modules and multiple gate driver modules corresponding to the liquid crystal panels **12***a*-**12***c*, which are basically the same as the source driver module **122** and the gate driver module **126** shown in FIG. **1**A, and therefore the details would be omitted in this embodiment.

In FIG. **1**B, multiple light-color sources **144***a*-**144***c* are used to generate different colors to the liquid crystal panels **12***a*-**12***c*. The colored light penetrating the liquid crystal panels **12***a*-**12***c* would be collected and converged by the converging lens **19**, to project the image to a screen **20**. In summary, the display control method in the embodiment may be implemented to various kinds of display apparatus, and types of the display apparatus are not meant to be a limitation of the present disclosure.

The following embodiments would explain more on how the above-mentioned display control method may control the on and off the multiple colored light sources of the light source module, adjust the intensity or brightness of the color light emitted from the multiple colored light sources, or the gray scale values of the sub-pixels in the frame by processing and computing the video data of the frame.

[Embodiment of a Display Control Method]

Please refer to FIGS. **2**A to **2**C. FIG. **2**A depicts an illustrative diagram of a frame having a white-tending sub frame and a color cast sub frame according to an embodiment of the present disclosure. FIG. **2**B shows an illustrative diagram of a frame having a white-tending sub frame, a non-white-tending and non-color cast sub frame, and a color cast sub frame according to an embodiment of the present disclosure. FIG. **2**C refers to an illustrative diagram of a frame having a non-white-tending and non-color cast sub frame and a color cast sub frame according to an embodiment of the present disclosure.

In FIG. **2**A, the frame **23** basically tends to a specific color and includes the color cast sub frame **201** and the white-tending sub frame **202**. The specific color may be divided into at least one of the colors corresponding to the multiple colored light sources. The color cast sub frame **201** tends to said specific color, and the white-tending sub frame **202** tends to white.

Because the color cast sub frame **201** tends to the specific color, the colored light sources corresponding to the specific light may be intensified and the colored light sources corresponding to colors other than the specific color may be reduced for the color cast sub frame **201**, in order to save power consumption. Because the color light of the specific color is intensified and the color light of the colors other than the specific color is reduced, the white-tending sub frame **202** may become slightly tend to the specific color, and correspondingly, the color temperature of the white-tending sub frame **202** may become slightly higher or lower.

Next, to prevent the white-tending sub frame **202** from tending to the specific color, the gray scale values of each sub-pixel of the specific color in the white-tending sub frame **202** may be decreased based on the level that the colored light source corresponding to the specific color is intensified. Then the modified gray scale values of each sub-pixel of the specific color in the white-tending sub frame **202** and the gray scale values each sub-pixel of colors other than the specific color in the white-tending sub frame **202** may be increased based on the level that the colored light sources corresponding to colors other than the specific color are reduced.

Finally, the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame **202** are replaced by the above-mentioned modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame **202**.

In FIG. **2**B, the frame **21** tends to a specific color and includes a color cast sub frame **211** and a non-white-tending and non-color cast sub frame **212**. The color cast sub frame **211** tends to said specific color, and the non-white-tending and non-color cast sub frame **212** don't tend to the specific color neither white color.

Because the frame **21** tends to the specific color, the colored light sources corresponding to the specific light may be intensified and the colored light sources corresponding to colors other than the specific color may be reduced for the frame **21** in order to save power consumption. Due to the colored light of the specific color is intensified and the colored light of the colors other than the specific color is reduced, the non-white-tending and non-color cast sub frame **212** may become slightly tend to the specific color.

Next, to prevent the non-white-tending and non-color cast sub frame **212** from tending to the specific color, the gray scale values of each sub-pixel of the specific color in the non-white-tending and non-color cast sub frame **212** may be decreased based on the level that the colored light source corresponding to the specific color is intensified to generate a plurality of modified gray scale values. Then the gray scale values of each sub-pixel of colors other than the specific color in the non-white-tending and non-color cast sub frame **212** may be increased based on the level that the colored light sources corresponding to colors other than the specific color are reduced.

At last, the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color of the non-white-tending and non-color cast sub frame **212** are replaced by the above-mentioned modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the non-white-tending and non-color cast sub frame **212**.

In FIG. **2**C, the frame **22** substantially tends to a specific color and includes the color cast sub frame **221**, the white-tending sub frame **222**, and the non-white-tending and non-color cast sub frame **223**. The color cast sub frame **221** tends to said specific color, while the white-tending sub frame **222** tends to white, and the non-white-tending and non-color cast sub frame **223** don't tend to the specific color neither white.

Because the frame **22** tends to the specific color, the colored light sources corresponding to the specific light may be intensified and the colored light sources corresponding to colors other than the specific color may be reduced for the frame **22** in order to save power consumption. Due to the color light of the specific color is intensified and the color light of the colors other than the specific color is reduced, the white-tending sub frame **221** and the non-white-tending and non-color cast sub frame **223** may become slightly tend to the specific color.

The modification made to the gray scale value of the white-tending sub frame **222** is identical to the way made to the white-tending sub frame **202** shown in FIG. **2**A, meanwhile, the modification made to the gray scale value of the non-white-tending and non-color cast sub frame **223** is identical to the way made to the non-white-tending and non-color cast sub frame **212** shown in FIG. **2**B. Therefore the same modification process would not be repeated again.

It is worth to mention, the frame **22** may be divided into several physical independent sub frames, wherein each of the physical independent sub frames corresponds to part of the multiple colored light sources. Furthermore, the color cast sub frame **221** may be composed by part of the several physical independent sub frames, the white-tending sub frame **222** composed by other part of the several physical independent sub frames, and the non-white-tending and non-color cast sub frame **223** be composed by another part of the several physical independent sub frames.

Moreover, in the present disclosure, intergrade zones **203** and **204** may be prepared between the boundary of the white-tending sub frame and the color cast sub frame. So that Chroma and the gray scale values of the sub-pixels of the specific color of the white-tending sub frame may be gradually changed in a tiered manner to those of the color cast sub frame. Interval of the tiers may be smaller than 10% of the Chroma and the gray scale values of the sub-pixels of the specific color, so that the changes presented between the edges of the white-tending sub frame and the color cast sub frame may be continuous instead of discrete. Also, an intergrade zone may be prepared between the edges of the white-tending sub frame and the non-white-tending and non-color cast sub frame. So that Chroma and the gray scale values of the sub-pixels of the color other than the specific color of the white-tending sub frame may be gradually changed in a tiered manner to those of the non-white-tending and non-color cast sub frame. Interval of the tiers may be smaller than 10% of the Chroma and the gray scale values of the sub-pixels of the color other than the specific color, so that the changes presented between the edges of the white-tending sub frame and the color cast sub frame may be continuous instead of discrete.

Thus, the multiple colored light sources may be dynamically switched on and off as well as the brightness and intensity being adjusted according to color tending in the frame **20**-**22**, so as to save more power and energy. Furthermore, when the Chroma and gray scale values of each sub-pixel of the above-mentioned white-tending sub frames **202** and **222** are adjusted, the sub frame **202** and **222** would tend to white. Meanwhile, the color temperature may be large than or equal

to 4000K and smaller than or equal to 12000K. In other words, the color temperature would be between 4000K and 12000K.

Next, based on the above-mentioned examples, one of the display control methods according to the embodiments of the present disclosure may be summarized. Please refer to FIG. **3** which shows a flow diagram of a display control method according to one embodiment of the present disclosure. Firstly, in step S**301**, the display control system would receive video data of a frame, and determine whether the frame tends to a specific color. If the frame tends to the specific color step S**302** is performed. Otherwise, if the frame does not tend to the specific color, the switch-on/off of the multiple colored light sources and the intensity or brightness of the color light need no adjustment, and the display control method may be exited.

In step S**302**, for the whole frame, the display control system intensifies the colored light source of the specific color the frame tends to, and reduces colored light sources of the colors other than the specific color. Next, in step S**303**, the display control system determines whether the frame includes the white-tending sub frame. When the white-tending sub frame is included, step S**304** is subsequently performed. Otherwise, when the white-tending sub frame is not included, processes for Chroma and the gray scale values of the sub-pixels of the white-tending sub frame would be not necessary, and step S**306** is followed.

In step S**304**, for the white-tending sub frame, the display control system decreases the gray scale values of each sub-pixel of the specific color in the white-tending sub frame based on the level that the colored light source corresponding to the specific color is intensified, in order to generate a plurality of modified gray scale values of each sub-pixel of the specific color in the white-tending sub frame. Precisely speaking, for the white-tending sub frame, the display control system refers to a first look-up table (LUT) or utilizes a first equation according to the level that the colored light source corresponding to the specific color is intensified and the gray scale values of the plurality of the sub-pixels of the specific color to generate the plurality of modified gray scale values.

Next, in step S**305**, for the white-tending sub frame, the display control system increases the modified gray scale values of each sub-pixel of the specific color in the white-tending sub frame and the gray scale values each sub-pixel of colors other than the specific color in the white-tending sub frame based on the level that the colored light sources corresponding to colors other than the specific color are reduced. The display control system then replaces the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame by the modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame.

More specifically, the display control system refers to at least a second look-up table or utilizes at least a second equation according to the level that the colored light sources corresponding to colors other than the specific color are reduced, the plurality of modified gray scale values of the sub-pixels, and the plurality of scale values of the sub-pixels corresponding to the colors other than the specific color to increase the plurality of modified gray scale values of the sub-pixels and the gray scale values of the sub-pixels of the colors other than the specific color in the white-tending sub frame. It is worth mentioning, the second look-up table or the second equation used by the gray scale values of the sub-pixels of different colors may be identical as well as different, which is not a limitation for the present disclosure.

In step S**306**, the display control system determines whether the frame includes the non-white-tending sub frame or non-color cast sub frame. When the non-white-tending and non-color cast sub frame is included, the system goes to step S**307**. On the other hand, when the non-white-tending and non-color cast sub frame are not included, processes for gray scale values of the sub-pixels in the non-white-tending and non-color cast sub frame would be not necessary, and the display control method may be exited.

In step S**307**, for non-white-tending and non-color cast sub frame, the display control system decreases the gray scale values of each sub-pixel of the specific color in the non-white-tending and non-color cast sub frame based on the level that the colored light source corresponding to the specific color is intensified, in order to generate a plurality of modified gray scale values of each sub-pixel of the specific color in non-white-tending and non-color cast sub frame. Precisely speaking, for the non-white-tending and non-color cast sub frame, the display control system refers to a third look-up table or utilizes a third equation according to the level that the colored light source corresponding to the specific color is intensified and the gray scale values of the plurality of the sub-pixels of the specific color, to generate the plurality of modified gray scale values.

In step S**308**, for the non-white-tending and non-color cast sub frame, the display control system increases the gray scale values of the sub-pixels of colors other than the specific color in the non-white-tending and non-color cast sub frame based on the level that the colored light sources corresponding to colors other than the specific color are reduced. The display control system then replaces the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color of the non-white-tending and non-color cast sub frame by the modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the non-white-tending and non-color cast sub frame.

More specifically speaking, for the non-white-tending and non-color cast sub frame, the display control system refers to at least a fourth look-up table or utilizes at least a fourth equation according to the level that the colored light sources corresponding to colors other than the specific color are reduced and the plurality of gray scale values of the sub-pixels corresponding to the colors other than the specific color to increase the plurality of modified gray scale values of the sub-pixels and the gray scale values of the sub-pixels of the colors other than the specific color in the non-white-tending and non-color cast sub frame. It is worth mentioning, the fourth look-up table or the fourth equation used by the gray scale values of the sub-pixels of different colors may be identical as well as different, which is not a limitation to the present disclosure.

In addition, in the present embodiment, the order of steps S**303**-S**305** and steps S**306**-**308** may be exchanged. In other words, the system may firstly determine whether the frame includes the non-white-tending and non-color cast sub frame, and process the gray scale values of the sub-pixels in the non-white-tending and non-color cast sub frame, then determine whether the frame includes the white-tending sub frame and process the gray scale values of the sub-pixels in the white-tending sub frame. In summary, sequences of the steps are not meant to limit the present disclosure.

Next, please refer to FIGS. **4**A to **4**C. FIG. **4**A shows a curve graph of the gray scale values of the sub-pixel of the

specific color and the modified gray scale values of the sub-pixels modified based on the intensified level of the colored light source of the specific color according to one embodiment of the present disclosure. FIG. **4**B shows a curve diagram of the modified gray scale values of the sub-pixel of the specific color and the modified gray scale values of the sub-pixels increased based on the reduced level of the colored light sources of the colors other than the specific color according to one embodiment of the present disclosure. FIG. **4**C shows a curve diagram of the gray scale values of the sub-pixel of the colors other than the specific color and the modified gray scale values of the sub-pixels increased based on the reduced level of the colored light source of the colors other than the specific color according to one embodiment of the present disclosure.

For example, when the multiple colored light sources include red, green, and blue light sources, and the red light source in the frame is intensified 10 times while the green and the blue light sources are reduced 5 times, the range of gray scale values of the sub-pixels of the specific color would become 0-25 from the range of 0-255 when the gray scale values of the sub-pixels of the specific color in the non-white-tending and non-color cast sub frame and the white-tending sub frame are reduced according to the intensified level of the colored light sources of the specific color, as shown in FIG. **4**A.

As shown in FIG. **4**B, when the modified gray scale values of the sub-pixels of the specific color in the white-tending sub frame is increased based on the reduced level of the colored light sources of the colors other than the specific color, the range of the modified gray scale values of the sub-pixels of the specific color in the white-tending sub frame would become 0-255 from 0-25. As shown in FIG. **4**C, when the gray scale values of the sub-pixels of the colors other than the specific color in the non-white-tending and non-color cast sub frame are increased based on the level that the colored light sources of the colors other than the specific color are reduced, the range of the gray scale values of the sub-pixels of the colors other than the specific color in the non-white-tending and non-color cast sub frame would not change and maintain 0-255.

Please note that when the modified gray scale values of the sub-pixels in the white-tending sub frame are increased based on the level that the colored light sources of the colors other than the specific color are reduced, the modified gray scale values are not equal to the original gray scale values of the sub-pixel of the specific color in the white-tending sub frame, neither the modification level of the gray scale values of the sub-pixels is inversely proportional to the adjustment level of colored light sources.

[Another Embodiment of a Display Control Method]

Please refer to FIGS. **5**A-**5**C. FIG. **5**A depicts an illustrative diagram of a frame having a white-tending sub frame and a color-lacking sub frame according to an embodiment of the present disclosure. FIG. **5**B shows an illustrative diagram of a frame having a white-tending sub frame, a non-white-tending and non-color-lacking sub frame, and a color-lacking sub frame according to an embodiment of the present disclosure. FIG. **5**C refers to an illustrative diagram of a frame having a non-white-tending and non-color-lacking sub frame and a color-lacking sub frame according to an embodiment of the present disclosure.

In FIG. **5**A, the frame **50** lacks for a specific color, and includes a color-lacking sub frame **501** and a white-tending sub frame **502**. The specific color may be divided into at least one of the colors corresponding to the multiple colored light sources. The color-lacking sub frame **501** lacks said specific color. Meanwhile, the white-tending sub frame **502** tends to white.

Because the color-lacking sub frame **501** lacks the specific color, the colored light sources corresponding to the specific light may be reduced and the colored light sources corresponding to colors other than the specific color may be intensified for the color-lacking sub frame **501** in order to save power consumption. Additionally, because the color light of the specific color is reduced and the color light of the colors other than the specific color is intensified, the white-tending sub frame **502** may slightly lack the specific color, and correspondingly, the color temperature of the white-tending sub frame **502** may become slightly higher or lower.

Next, to prevent the white-tending sub frame **502** from lacking for the specific color, the gray scale values of each sub-pixel of the specific color in the white-tending sub frame **502** may be increased based on the level that the colored light source corresponding to the specific color is reduced, in order to generate a plurality of modified gray scale values of the sub-pixels. Then the modified gray scale values of the sub-pixels of the specific color in the white-tending sub frame **502** and the gray scale values each sub-pixel of colors other than the specific color in the white-tending sub frame **502** may be decreased based on the level that the colored light sources corresponding to colors other than the specific color are intensified.

Finally, the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color in the white-tending sub frame **502** are replaced by the above-mentioned modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame **502**.

In FIG. **5**B, the frame **51** lacks a specific color, and includes a color-lacking sub frame **511** and a non-white-tending and non-color-lacking sub frame **512**. The color-lacking sub frame **511** lacks said specific color, and the non-white-tending and non-color-lacking sub frame **512** doesn't lack the specific color or tend to white color.

Because the frame **51** lacks for the specific color, the colored light sources corresponding to the specific light may be reduced and the colored light sources corresponding to colors other than the specific color may be intensified for the frame **51** in order to save power consumption. Because the color light of the specific color is reduced and the color light of the colors other than the specific color is intensified, the non-white-tending and non-color-lacking sub frame **512** may slightly lack for the specific color.

Next, to prevent the non-white-tending and non-color-lacking sub frame **512** from lacking for the specific color, the gray scale values of each sub-pixel of the specific color in the non-white-tending and non-color-lacking sub frame **512** may be increased based on the level that the colored light source corresponding to the specific color is reduced to generate a plurality of modified gray scale values. Then the gray scale values of each sub-pixel of colors other than the specific color in the non-white-tending and non-color-lacking sub frame **512** may be decreased based on the level that the colored light sources corresponding to colors other than the specific color are intensified.

At last, the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame **512** are replaced by the above-mentioned modified gray scale values

of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the non-white-tending and non-color-lacking sub frame **512**.

In FIG. **5**C, the frame **52** lacks for a specific color and includes a color-lacking sub frame **521**, the white-tending sub frame **522**, and a non-white-tending and non-color-lacking sub frame **523**. The color-lacking sub frame **521** lacks for said specific color, while the white-tending sub frame **522** tends to white, and the non-white-tending and non-color-lacking sub frame **523** doesn't lack for the specific color neither tends to white.

Because the frame **52** lacks for the specific color, the colored light sources corresponding to the specific light may be reduced and the colored light sources corresponding to colors other than the specific color may be intensified in the frame **52** in order to save power consumption. Because the color light of the specific color is intensified and the color light of the colors other than the specific color is reduced, the white-tending sub frame **521** and the non-white-tending and non-color-lacking sub frame **523** may slightly lack for the specific color.

The modification made to the gray scale value of the white-tending sub frame **522** is identical to the way made to the white-tending sub frame **502** shown in FIG. **5**A, meanwhile, the modification made to the gray scale value of the non-white-tending and non-color-lacking sub frame **523** is identical to the way made to the non-white-tending and non-color-lacking sub frame **512** shown in FIG. **5**B. Therefore the same modification process would not be repeated again.

It is worth to mention, the frame **52** may be divided into several physical independent sub frames, wherein each of the physical independent sub frames corresponds to part of the multiple colored light sources. Furthermore, the color-lacking sub frame **521** may be composed by part of the several physical independent sub frames, the white-tending sub frame **522** may be composed by other part of the several physical independent sub frames, and the non-white-tending and non-color-lacking sub frame **523** may be composed by another part of the several physical independent sub frames.

Moreover, in the present disclosure, an intergrade zone may be prepared between the boundary of the white-tending sub frame and the color-lacking sub frame. In this regard, Chroma and the gray scale values of the sub-pixels of the specific color of the white-tending sub frame may be gradually changed in a tiered manner to those of the color-lacking sub frame. Intervals of the tiers may be smaller than 10% of the Chroma and the gray scale values of the sub-pixels of the specific color, so that the changes presented between the boundary of the white-tending sub frame and the color-lacking sub frame may be continuous instead of discrete. Also, an intergrade zone may be prepared between the edges of the white-tending sub frame and the non-white-tending and non-color-lacking sub frame. Thus Chroma and the gray scale values of the sub-pixels of the color other than the specific color of the white-tending sub frame may be gradually changed in a tiered manner to those of the non-white-tending and non-color-lacking sub frame. Intervals of the tiers may be smaller than 10% of the Chroma and the gray scale values of the sub-pixels of the color other than the specific color, so that the changes presented between the edges of the white-tending sub frame and the non-white-tending and non-color-lacking sub frame may be continuous instead of discrete. Thus, the multiple colored light sources may be dynamically switched on and off as well as the brightness and intensity being adjusted according to color lacking in the frame **50**-**52**, so as to save more power and energy. Furthermore, when the Chroma and gray scale values of each sub-pixel of the above-mentioned white-tending sub frames **502** and **522** are adjusted, the sub frame **502** and **522** would tend to white. Meanwhile, the color temperature may be larger than or equal to 4000K and smaller than or equal to 12000K. In other words, the color temperature would be between 4000K and 12000K.

Next, based on the above-mentioned examples, one of the display control methods according to the embodiments of the present disclosure may be summarized. Please refer to FIG. **6** which shows a flow diagram of a display control method according to one embodiment of the present disclosure. Firstly, in step S**601**, the display control system would receive video data of a frame, and determine whether the frame lacks a specific color. If the frame lacks for the specific color, step S**602** is performed. Otherwise, if the frame does not lack for the specific color, the switch-on/off of the multiple colored light sources and the intensity or brightness of the color light need not to be adjusted, and the display control method may be exited.

In step S**602**, for the entire frame, the display control system reduces the colored light source of the specific color the frame lacks, and intensified colored light sources of the colors other than the specific color. Next, in step S**603**, the display control system determines whether the frame includes the white-tending sub frame. When the white-tending sub frame is included, step S**604** is subsequently performed. Otherwise, when the white-tending sub frame is not included, processes for Chroma and the gray scale values of the sub-pixels of the white-tending sub frame would not be necessary, and step S**606** carries on.

In step S**604**, for the white-tending sub frame, the display control system increases the gray scale values of each sub-pixel of the specific color in the white-tending sub frame based on the level that the colored light source corresponding to the specific color is reduced in order to generate a plurality of modified gray scale values of each sub-pixel of the specific color in the white-tending sub frame. Precisely speaking, for the white-tending sub frame, the display control system refers to a fifth look-up table or utilizes a fifth equation according to the level that the colored light source corresponding to the specific color is reduced and the gray scale values of the plurality of the sub-pixels of the specific color to generate the plurality of modified gray scale values.

Next, in step S**605**, for the white-tending sub frame, the display control system decreases the modified gray scale values of each sub-pixel of the specific color in the white-tending sub frame and the gray scale values each sub-pixel of colors other than the specific color in the white-tending sub frame based on the level that the colored light sources corresponding to colors other than the specific color are intensified. The display control system then replaces the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame by the modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color of the white-tending sub frame.

More specifically speaking, the display control system refers to at least a sixth look-up table or utilizes at least a sixth equation according to the level that the colored light sources corresponding to the colors other than the specific color are intensified, the plurality of modified gray scale values of the sub-pixels, and the plurality of gray scale values of the sub-pixels corresponding to the colors other than the specific color to decrease the plurality of modified gray scale values of the

sub-pixels and the gray scale values of the sub-pixels of the colors other than the specific color in the white-tending sub frame. It is worth mentioning, the sixth look-up table or the sixth equation used by the gray scale values of the sub-pixels of different colors may be identical as well as different, which is not a limitation to the present disclosure.

In step **S606**, the display control system determines whether the frame includes the non-white-tending and non-color-lacking sub frame. When the non-white-tending and non-color-lacking sub frame is included, the system goes to step **S607**. On the other hand, when the non-white-tending and non-color-lacking sub frame is not included, processes for gray scale values of the sub-pixels in the non-white-tending and non-color-lacking sub frame would not be necessary, and the display control method may be exited.

In step **S607**, for the non-white-tending and non-color-lacking sub frame, the display control system increases the gray scale values of each sub-pixel of the specific color in the non-white-tending and non-color-lacking sub frame based on the level that the colored light source corresponding to the specific color is reduced, in order to generate a plurality of modified gray scale values of each sub-pixel of the specific color in the non-white-tending and non-color-lacking sub frame. Precisely speaking, for the non-white-tending and non-color-lacking sub frame, the display control system refers to a seventh look-up table or utilizes a seventh equation according to the level that the colored light source corresponding to the specific color is reduced and the gray scale values of the plurality of the sub-pixels of the specific color for reducing the plurality of gray scale values of each sub-pixel of the specific color in the non-white-tending and non-color-lacking sub frame to generate the plurality of modified gray scale values.

In step **S608**, for the non-white-tending and non-color-lacking sub frame, the display control system decreases the gray scale values of the sub-pixels of colors other than the specific color in the non-white-tending and non-color-lacking sub frame based on the level that the colored light sources corresponding to colors other than the specific color are intensified. The display control system then replaces the original gray scale values of each sub-pixel of the specific color and the original gray scale values of each sub-pixel of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame by the modified gray scale values of each sub-pixel of the specific color and the modified gray scale values of each sub-pixel of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame.

More specifically speaking, for the non-white-tending and non-color-lacking sub frame, the display control system refers to at least an eighth look-up table or utilizes at least an eighth equation according to the level that the colored light sources corresponding to colors other than the specific color are intensified and the plurality of gray scale values of the sub-pixels corresponding to the colors other than the specific color, to decrease the plurality of modified gray scale values of the sub-pixels and the gray scale values of the sub-pixels of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame. It is worth mentioning, the eighth look-up table or the eighth equation used by the gray scale values of the sub-pixels of different colors may be identical as well as different, which is not a limitation to the present disclosure.

In addition, in the present embodiment, the order of steps **S603**-**S605** and steps **S606**-**S608** may be exchanged. In other words, the system may firstly determine whether the frame includes the non-white-tending and non-color-lacking sub frame, and process the gray scale values of the sub-pixels in the non-white-tending and non-color-lacking sub frame, then determine whether the frame includes the white-tending sub frame and process the gray scale values of the sub-pixels in the white-tending sub frame. In summary, sequences of the steps are not meant to limit the present disclosure.

Next, please refer to FIGS. **7**A to **7**C. FIG. **7**A shows a curve diagram of the gray scale values of the sub-pixel of the specific color and the modified gray scale values of the sub-pixels increased based on the reduced level of the colored light source of the specific color according to one embodiment of the present disclosure. FIG. **7**B shows a curve diagram of the modified gray scale values of the sub-pixel of the specific color and the modified gray scale values of the sub-pixels decreased based on the intensified level of the colored light sources of the colors other than the specific color according to one embodiment of the present disclosure. FIG. **7**C shows a curve diagram of the gray scale values of the sub-pixel of the colors other than the specific color and the modified gray scale values of the sub-pixels decreased based on the intensified level of the colored light source of the colors other than the specific color according to one embodiment of the present disclosure.

For example, when the multiple colored light sources include red, green, and blue light sources, and the red light source in the frame is intensified 10 times while the green and the blue light sources are reduced 5 times, the range of gray scale values of the sub-pixels of the specific color in the non-white-tending and non-color-lacking sub frame would stay unchanged as 0-255 after the gray scale values are increased based on the level that the colored light source of the specific color is reduced, as shown in FIG. **7**A.

As FIG. **7**B shows, when the modified gray scale values of the sub-pixels of the specific color in the white-tending sub frame is decreased based on the intensified level of the colored light sources of the colors other than the specific color, the range of the modified gray scale values of the sub-pixels of the specific color in the white-tending sub frame would become 0-25 from 0-255. As FIG. **7**C shows, when the gray scale values of the sub-pixels of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame are decreased based on the level that the colored light sources of the colors other than the specific color are intensified, the range of the gray scale values of the sub-pixels of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame would not change and maintain as 0-255.

Please note that when the modified gray scale values of the sub-pixels in the white-tending sub frame are decreased based on the level that the colored light sources of the colors other than the specific color are intensified, the modified gray scale values are not equal to the original gray scale values of the sub-pixel of the specific color in the white-tending sub frame, neither the modification level of the gray scale values of the sub-pixels is inversely proportional to the adjustment level of colored light sources.

[Possible Effects of the Embodiments]

According to the embodiments of the present disclosure, the display apparatus and the display control method could reduce power consumption caused by the multiple colored light sources of the display apparatus. Furthermore, it does not require greater complexity to implement the display apparatus and the display control method, and thus the device and the method are suitable for mass producing related products and are highly practical.

Moreover, since the display control method may effectively compensate the gray scale values of the sub-pixels of

white-tending sub frames, non-white-tending and non-color cast sub frames, or non-white-tending and non-color-lacking sub frames, and therefore color cast or color lacking in white-tending sub frames, non-white-tending and non-color cast sub frames, and non-white-tending and non-color-lacking sub frames could be prevented.

The descriptions illustrated supra set forth simply the preferred embodiments of the instant disclosure; however, the characteristics of the instant disclosure are by no means restricted thereto. All changes, alternations, or modifications conveniently considered by those skilled in the art are deemed to be encompassed within the scope of the instant disclosure delineated by the following claims.

What is claimed is:

1. A display control method, adapted to a display apparatus having a plurality of colored light sources used to emit a plurality of different colored lights, in which a frame of the display apparatus includes at least a color cast sub frame and at least a white-tending sub frame, wherein the color cast sub frame tends to at least a specific color that is able to be divided into at least one of the colored light of the one or more different colors, the method comprising:

for the frame, intensifying the colored light source of the specific color and reducing the colored light sources of colors other than the specific color;

for the white-tending sub frame, decreasing a plurality of gray scale values corresponding to the specific color in the white-tending sub frame based on a level that the colored light source of the specific color is intensified, to generate a plurality of modified gray scale values; and

for the white-tending sub frame, increasing the plurality of modified gray scale values and a plurality of gray scale values corresponding to the colors other than the specific color based on a level that the colored light sources of the colors other than the specific color are reduced.

2. The display control method according to claim **1**, wherein on, off, adjustment, intensity, and brightness of the colored light sources is dynamically adjusted based on the color cast.

3. The display control method according to claim **1**, wherein after processing the plurality of gray scale values of the white-tending sub frame, the white-tending sub frame tends to white or pale white.

4. The display control method according to claim **1**, wherein color temperature of the white-tending sub frame is between 4000K and 12000K.

5. The display control method according to claim **1**, wherein the frame further includes at least a non-white-tending and non-color cast sub frame and the method further comprises:

for the non-white-tending and non-color cast sub frame, decreasing a plurality of gray scale values corresponding to the specific color in the non-white-tending and non-color cast sub frame based on a level that the colored light source of the specific color is intensified, to generate a plurality of modified gray scale values; and

for the non-white-tending and non-color cast sub frame, increasing a plurality of gray scale values corresponding to the colors other than the specific color based on a level that the colored light sources of the colors other than the specific color are reduced.

6. The display control method according to claim **1**, wherein for the white-tending sub frame, based on the level that the colored light source of the specific color is intensified and the gray scale values of the specific color, a first look-up table or a first equation is referred to decrease the plurality of gray scale values of the specific color in the white-tending sub frame, in order to generate the plurality of modified gray scale values of the sub-pixels, or based on the level that the colored light sources of the colors other than the specific color are reduced, the plurality of modified gray scale values, and the gray scale values of the colors other than the specific color, at least a second look-up table or at least a second equation is referred to increase the plurality of modified gray scale values of the specific color and a plurality of gray scale values of the colors other than the specific color in the white-tending sub frame.

7. The display control method according to claim **6**, wherein for the non-white-tending and non-color cast sub frame, based on the level that the colored light source of the specific color is intensified and the gray scale values of the specific color, a third look-up table or a third equation is referred to decrease the plurality of gray scale values of the specific color in the non-white-tending and non-color cast sub frame, in order to generate the plurality of modified gray scale values of the sub-pixels, or based on the level that the colored light sources of the colors other than the specific color are reduced and the gray scale values of the colors other than the specific color, at least a fourth look-up table or at least a fourth equation is referred to increase a plurality of gray scale values of the colors other than the specific color in the non-white-tending and non-color cast sub frame.

8. The display control method according to claim **1**, wherein the frame is divided into a plurality of physical independent sub frames which corresponds to a portion of the colored light sources, wherein the color cast sub frame is composed of a portion of the plurality of physical independent sub frames, and the white-tending sub frame is composed of the rest of the plurality of physical independent sub frames.

9. The display control method according to claim **1**, wherein the colored light emitted from the plurality of colored light sources provides various different adjustable intensities by dividing into a plurality of sectional frame and/or a plurality of time sequences.

10. The display control method according to claim **1**, wherein an intergrade zone is prepared between a boundary of the white-tending sub frame and the color cast sub frame for gradually changing Chroma and the gray scale values of the sub-pixels between the white-tending sub frame and the color cast sub frame in a tiered manner, or/and an intergrade zone is prepared between a boundary of the white-tending sub frame and the non-color cast sub frame for gradually changing Chroma and the gray scale values of the sub-pixels between the white-tending sub frame and the non-color cast sub frame in a tiered manner.

11. A display control method, adopted to a display apparatus having a plurality of colored light sources used to emit a plurality of color light of different colors, in which a frame of the display apparatus includes at least a color-lacking sub frame and at least a white-tending sub frame, wherein the color-lacking sub frame lacks in at least a specific color that is able to be divided into at least one of the colored light of the one or more different colors, the method comprising:

for the frame, reducing the colored light source of the specific color and intensifying the colored light sources of colors other than the specific color;

for the white-tending sub frame, increasing a plurality of gray scale values corresponding to the specific color in the white-tending sub frame based on a level that the colored light source of the specific color is reduced, to generate a plurality of modified gray scale values; and

for the white-tending sub frame, decreasing the plurality of modified gray scale values and a plurality of gray scale

values corresponding to the colors other than the specific color based on a level that the colored light sources of the colors other than the specific color are intensified.

12. The display control method according to claim **11**, wherein on, off, adjustment, intensity, and brightness of the colored light sources is dynamically adjusted based on the color lacking.

13. The display control method according to claim **11**, wherein after processing the plurality of gray scale values of the white-tending sub frame, the white-tending sub frame tends to white or pale white.

14. The display control method according to claim **11**, wherein color temperature of the white-tending sub frame is between 4000K and 12000K.

15. The display control method according to claim **11**, wherein the frame further includes at least a non-white-tending and non-color-lacking sub frame and the method further comprises:

for the non-white-tending and non-color-lacking sub frame, increasing a plurality of gray scale values corresponding to the specific color in the non-white-tending and non-color-lacking sub frame based on a level that the colored light source of the specific color is reduced, to generate a plurality of modified gray scale values; and

for the non-white-tending and non-color-lacking sub frame, decreasing a plurality of gray scale values corresponding to the colors other than the specific color in the non-white-tending and non-color-lacking sub frame based on a level that the colored light sources of the colors other than the specific color are intensified.

16. The display control method according to claim **11**, wherein for the white-tending sub frame, based on the level that the colored light source of the specific color is reduced and the gray scale values of the specific color, a fifth look-up table or a fifth equation is referred to increase the plurality of gray scale values of the specific color in the white-tending sub frame, in order to generate the plurality of modified gray scale values of the sub-pixels, or based on the level that the colored light sources of the colors other than the specific color are intensified, the plurality of modified gray scale values, and the gray scale values of the colors other than the specific color, at least a sixth look-up table or at least a sixth equation is referred to decrease the plurality of modified gray scale values of the specific color and a plurality of gray scale values of the colors other than the specific color in the white-tending sub frame.

17. The display control method according to claim **16**, wherein for the non-white-tending and non-color-lacking sub frame, based on the level that the colored light source of the specific color is reduced and the gray scale values of the specific color, a seventh look-up table or a seventh equation is referred to increase the plurality of gray scale values of the specific color in the non-white-tending and non-color-lacking sub frame, in order to generate the plurality of modified gray scale values of the sub-pixels, or based on the level that the colored light sources of the colors other than the specific color are intensified and the gray scale values of the colors other than the specific color, at least an eighth look-up table or at least an eighth equation is referred to decrease a plurality of gray scale values of the colors other than the specific color in the non-white-tending and non-color-lacking sub frame.

18. The display control method according to claim **11**, wherein the frame is divided into a plurality of physical independent sub frames which correspond to a portion of the colored light sources, wherein the color-lacking sub frame is composed of a portion of the multiple physical independent sub frames, and the white-tending sub frame is composed of the rest of the multiple physical independent sub frames.

19. The display control method according to claim **11**, wherein the color light emitted from the multiple colored light sources provide various different adjustable intensities by dividing into a plurality of sectional frames and/or a plurality of time sequences.

20. The display control method according to claim **11**, wherein an intergrade zone is prepared between a boundary of the white-tending sub frame and the color-lacking sub frame for gradually changing Chroma and the gray scale values of the sub-pixels between the white-tending sub frame and the color-lacking sub frame in a tiered manner, or/and an intergrade zone is prepared between a boundary of the white-tending sub frame and the non-white-tending and non-color-lacking sub frame for gradually changing Chroma and the gray scale values of the sub-pixels between the white-tending sub frame and the non-white-tending and non-color-lacking sub frame in a tiered manner.

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